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Simultaneous aerodynamic pressure measurements and modern structural design for wind

Statement of the Problem: The effectiveness of structural design for wind depends upon the quality of the aerodynamic input to the design process. The estimation of wind-induced loading on structures was originally based on measurements at small numbers of taps, yielding pressure time histories but no information on spatial coherences. The loading estimates were therefore largely subjective. The subjective component of the estimates was reduced somewhat by the later development of devices allowing the measurement of moments and shears at the base of the building but providing no information on the load distribution on the building. Only following the development in the 1990s of the pressure scanner, which allows the simultaneous measurement in the wind tunnel of pressure time series at hundreds of pressure taps, could the data needed to fully define the aerodynamic and dynamic loading be obtained. This development, and the new availability of the requisite computational power, allowed the recent development of a novel conceptual basis for the accurate, differentiated, and risk-consistent design of thousands of structural members.

Methodology & Theoretical Approach: Unlike in past practices, the modern approach to structural design for wind makes it possible to clearly separate the tasks of the wind engineer, including the requisite aerodynamic measurements, from the tasks of the designer, which include the determination of the structure's dynamic behavior. The paper describes the methodology by which time histories of pressures (Figure 1) at large numbers of taps can be used to obtain peak wind effects that can be used directly for the sizing of structural members.

Conclusion & Significance: In addition to achieving safer and more economical designs, the procedure described herein creates a demand for an enhanced role of the aerodynamicist, wherein simultaneous pressure time histories for bluff bodies in shear, turbulent flow would be obtained by numerical simulation, instead of in the wind tunnel. The paper discusses preliminary results of efforts aimed to achieve this goal.

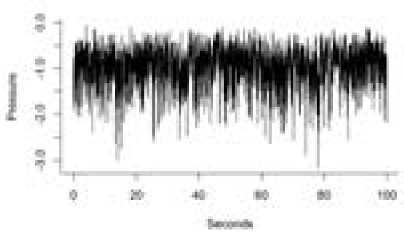

Figure1: *Record of pressure coefficients measured on a wind tunnel model.*

Biography

Emil Simiu is a NIST Fellow, National Institute of Standards and Technology, and a Professor of Practice in Wind Engineering, Florida International University. He is the author or co-author of *Wind Effects of Structures* (Russian translation, 1981; Chinese translation 1984), to be published in a 4th ed. by Wiley (2018), *Chaotic Transitions in Deterministic and Stochastic Dynamical Systems* (Princeton Univ. Press, 2001), *Design of Buildings for Wind*, 2nd ed., (Wiley 2011), and *A Modern Course in Aeroelasticity* (4th ed., Kluwer, 2004; Chinese translation, 2013).

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